PATENT APPLICATION

Storage Device Having a Capability of Learning Access Patterns

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STORAGE DEVICE HAVING A CAPABILITY OF LEARNING ACCESS PATTERNS

BACKGROUND OF THE INVENTION

The present invention relates to a method of reading information from a disk device out to a computer in a storage device to be used for a plurality
5 of computers, a method of designating the read, and a computer for executing the designating method.

As a technology of improving a data transfer rate in the conventional storage device, a read-ahead technology has been devised which technology is
10 described in, for example, JP-A-01-082239. The word "read-ahead" termed herein means an operation of the storage device of pre-reading data to be likely designated to be read out by an external device from a storage medium to another one. For example, the 082239
15 publication discloses the following reading operation: In response to a data readout designation to be given from a computer, the storage device operates to read out the designated data and the data following the designated data by a predetermined length, for example,
20 several blocks, from a physical location of a storage medium such as a disk device in which the designated data is stored. The storage device saves the read data in a cache memory with a faster readout speed than the disk device or the like.

The read-ahead operation eliminates the necessity of reading data from the disk device or the like in the case of reading out the data temporarily saved in the cache memory. Further, since the data is read out of the cache memory, the data transfer rate is improved.

Further, JP-A-03-102443 discloses the technology which improves the read-ahead performance and makes the efficient use of the storage medium to be used for the read-ahead possible. In this technology, in the read-ahead operation (often referred simply to as the read-ahead), the storage device determines if the access pattern of a computer that uses the storage device is a sequential read access or a random read access based on a history of a predetermined number of accesses. Then, if the access pattern is determined to be the sequential read access that is more effective in the read-ahead, the storage device executes the read-ahead operation. This makes it possible to improve the read-ahead performance in the sequential read access and more efficiently use the storage medium to be used for the read-ahead.

Further, JP-A-10-091497 discloses the technology of improving the performance of pre-reading a file in the storage device. In this technology, the storage device pre-records an information on the history regarding access operation to physical location of the storage device, and the device performs an

operation of pre-reading a file by using this history

information even if the access pattern is not the

sequential read access but the random read access.

Further, JP-A-08-87435 discloses the

5 technology of providing a plurality of read-ahead

buffers in a file server device for the purpose of

controlling the read-ahead for each terminal.

In the prior art, as mentioned above, the

storage device determines the access pattern to be

10 given from the computer based on the access history and

then performs the read-ahead when the access pattern is

determined to be the sequential read access.

In the other prior art, if the access pattern

is the random read access, the storage device compares

15 a file reading command with the information on the

physical location recorded in the storage device. And,

if the read-ahead is determined to be possible based on

the compared result, the storage device executes the

read-ahead operation.

20 In the foregoing prior arts, however, in a

case that a plurality of computers share one storage

device, if two or more of these computers access one

storage device, the storage device disables to manage

each access history for each computer only based on the

25 access history and the information on the physical

location in the storage device. That is, if a

plurality of computers request the random read access

pattern, the storage device obtains the access history

without classifying the access histories for each
computer. Hence, it is quite difficult to determine
that the access is executed on the random access
pattern based on the access history.

5   In order to solve the aforementioned problem,
JP-A-08-87435 discloses the method of collecting access
histories by locating in a file server a processor or a
buffer for collecting access histories for each
terminal. However, location of lots of processors or
10 buffers in the file sever or the storage device makes
the overall storage device more costly. This is not
preferable.

          Further, the foregoing prior art is arranged
to collect history information on the physical location
15 to be accessed in the random read access. If the prior
art includes the method of designating the start or the
end of the history information collection to the
storage device, the storage device is required to
collect a massive amount of histories and detect the
20 common history from the collection. This burdens the
process with heavy load.

          In the prior art, the storage device does not
start the read-ahead operation until the sequential
access or the access stored as a history is required by
25 the storage device. However, the prior art does not
consider the read-ahead operation in the case of the
start of the computer or the start of an application
program caused by job management software.

SUMMARY OF THE INVENTION

An object of the invention is to reduce the load on management of an access history in the storage device, the area of managing the access history, and

5   improving the reading performance.

According to an aspect of the invention, in order to solve the foregoing problems, the storage device is inputted with information for identifying a computer and information for specifying a history and

10   records the access history of a computer to be specified on the inputted information in linkage with the information for specifying the history. Then, when the information for identifying the computer and the information for specifying the history are transmitted

15   to the storage device, the storage device performs the read-ahead operation of the data based on the history corresponding with the transmitted information.

The other features of the present invention will be apparent from the present specification and the

20   appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing a configuration of a system according to an embodiment of the present invention.

25   Fig. 2 is a table illustrating an example of a history information saving table.

Fig. 3 is a table illustrating commands to be

transferred between a storage device 101 and a management computer 108.

Fig. 4 is a flowchart illustrating a process of collecting access histories in starting a computer.

Fig. 5 is a flowchart illustrating a read-ahead process when a computer is started.

Fig. 6 is a view showing an example of a network packet.

Fig. 7 is a table showing an example of a computer group saving table.

Fig. 8 is a table showing an example of a history management table.

Fig. 9 is a table showing an example of a job management table.

Fig. 10 is a flowchart showing an automated read-ahead process.

DESCRIPTION OF THE EMBODIMENTS

Hereafter, the description will be expanded on the embodiments of the invention.

Fig. 1 is a diagram showing an arrangement of a system having a storage device to which the present invention applies.

The system as shown in Fig. 1 includes a storage device 101, a management computer 108, a network server 110, and a plurality of computers 111 to be used by the user of the system. Those devices are connected with one another through a network 109.

The computer 111 or the management computer 108 is a general-purpose computer provided with a processor, a memory, I/O units, and so forth.

The plurality of computers 111 share the storage device 101. Hence, the computers 111 read the data, the application programs, and the operating system from the storage device 101, and then use them.

The storage device 101 includes a plurality of disk devices 104, a processor 102 for controlling the plurality of disk devices 104 (referred to as a disk group), a disk interface 103 for controlling transfer of data between the processor and the disk group, a network interface 105 connected with a network 109 for exchanging information with the computer 111, a cache memory 107 for holding data to be read out of the disk device 104 or to be saved therein, and a cache control unit 106 for saving information used for controlling the cache memory 107.

The storage device 101 operates to exchange information with the management computer 108, the network server 110, and the computer 111 through the network 109.

In this embodiment, the storage device 101 obtains an access history such as data readout from the storage device 101 for each computer 111 and then stores the access history for each computer in the cache control unit 106. Then, the storage device executes the read-ahead of the data in the disk group

104 and puts it in the cache memory 107. The

arrangement of the storage device 101 is not limited to

the foregoing arrangement. The necessary components in

the arrangement is only the control unit, the disk

5 device(s), and the cache memory 107.

In this embodiment, the processor 102

controls the cache memory 107 of the storage device 101

based on the management information and the management

program to be saved in the cache control unit 106.

10 Also in this embodiment, the cache control

unit 106 is composed of a nonvolatile semiconductor

memory and the cache memory 107 is composed of a

volatile semiconductor memory. In order to prevent

loss of data to be saved in the cache memory 107, the

15 cache memory 107 may be composed of a nonvolatile

memory. Or an arrangement for constantly securing a

power (for example, a spared power source) may be added

to the volatile cache memory.

Fig. 2 shows an exemplary configuration of a

20 history information saving table in this embodiment.

The history information saving table saves information

on the access history to the storage device 101 for

each computer 111. Further, the history information

saving table is saved in the cache control unit 106.

25 The history information saving table includes a history

information management table 301 and a history

information saving list 302.

For each access to be given by the computer

111, the storage device 101 determines if the access is given by the computer 111 that is designated to collect the history by the management computer 108. If the access is given for collecting the history, the content

5 of the access is added to the history information saving list 302 as a new access history. In this case, the processor 102 of the storage device 101 is linked with the history information management table 301 and the added access history. The history information

10 saving list 302 is managed by the history information management table 301.

The history information management table 301 includes the corresponding entry to each computer 111 that uses the storage device 101. Each entry includes

15 a field in which a computer ID allocated to the computer 111 for the entry is registered, another field in which a physical network ID allocated to the computer 111 for the entry is registered, and a plurality of fields in which the history IDs are

20 registered. Herein, the computer ID means an identifier to be allocated to the computer 111 by the management computer 108. In this embodiment, as the computer ID is used the MAC (Media Access Control) address or the World Wide Name to be properly allocated

25 to the computer. The computer ID is not limited to them.

The physical network ID is an identifier to be given to the computer 111 in the network inside the

system of this embodiment.   As an example of the

physical network ID, an IP address used in the internet

protocol, or a World Wide Name or a MAC address to be

individually given to each computer 111 may be referred.

5   In addition, these illustrated identifiers may be

dynamically given by another computer, for example, the

network server 110 each time the computer is started

111.   In this case, each time the identifier is

dynamically given, the storage device 101 updates

10   information of the physical network ID in the history

information management table 301.

The history ID can be an identifier allocated

to each access pattern for identifying an access

pattern to the storage device 101 to be given by the

15   computer 111, for example, a sequential access, a

random access, or an access pattern to the storage

device 101 when the computer 111 is started. Since the

plurality of computers 111 may provide the same access

patterns, the same history ID may be registered in the

20   field in which the history ID for each entry of the

history information management table 301 is to be

registered.

The entry for each computer 111 included in

the history information management table 301 has a

25   plurality of fields for registering the history ID, for

the purpose of managing a plurality of access patterns

to be given to the storage device 101 of the computer

111, respectively.

The history information saving list 302 is linked with the history ID described in the history information management table 301 and includes a plurality of access histories registered therein. When an access is received by the storage device 101, each access history includes the information for indicating the access location at which the data is read out of the disk group 104 by the storage device 101.

The access histories saved in the history information management list 302 are linked with one another through the use of the link structure and the fields in which the history IDs for the access histories listed in the history information management table 301 are registered. This link makes it possible for the storage device 101 to manage each access history registered in the history information management list 302 through the use of the history ID, concretely, to grasp the corresponding access pattern of the corresponding computer 111 with each access history. As mentioned above, this linkage is established as follows: When the storage device 101 accepts a certain access request from each computer 111, the storage device 101 registers the access history in the history information management list 302 and links the access history registered in the history information management list 302 with the field of the corresponding history ID of the corresponding computer 111 with the access history.

Fig. 3 is a table showing exemplary commands to be transferred between the storage device 101 of this embodiment and the management computer 108. The user of the management computer 108, for example, the

5 administrator of this system enables to control the operations such as start, end, and read-ahead start of the access history collection in the storage device 101 by causing the management computer 108 to transmit these commands to the storage device 101. Hereafter,

10 each command will be briefly described.

A command "StartRec" is used for specifying a computer ID and a history ID and then designating the start of the access history collection of the computer 111 specified by the computer ID to the storage device

15 101. The specified history ID is added to the collected access history.

A command "EndRec" is used for specifying a computer ID and a history ID and designating the end of the access history collection of the computer 111

20 specified by the computer ID to the storage device 101.

A command "TimeoutRec" is used for specifying a computer ID, a history ID, and a time and specifying to the storage device 101 a limitation time such as a time when the access history collection is

25 automatically stopped if a certain length of time is passed since the access start or a time when the access history collection is stopped if an access is ceased a predetermined time later than the access start.

A command "PointRec" is used for specifying a computer ID, a history ID, and a condition of starting history collection such as read from and write to a specific location of the storage device or read from a

5   consecutive specific locations and, if the specified history collection start condition is met, designating the storage device 101 to start the access history collection of the computer 111 specified by the computer ID without the StartRec command given by the

10   management computer 108.

A command "FlushRec" is used for specifying a computer ID and a history ID and designating the storage device 101 to erase the access history registered in the history information saving list 302

15   saved in the cache control unit 106 defined by the specified computer ID and history ID.

A command "StartRead" is used for specifying a computer ID and a history ID and designating the storage device 101 to execute the read-ahead operation

20   of the disk group into the cache memory 107 based on the access pattern of the corresponding computer 111 with the specified computer ID and history ID.

A command "PointRead" is used for specifying a computer ID, a history ID and a read-ahead starting

25   condition, and, if the read-ahead starting condition is met, designating the storage device 101 to start the read-ahead of data from the disk group to the cache memory 107 based on the access pattern of the specified

computer 111 without the StartRead command given by the management computer 108.

A command "RegistID" is used when the management computer 108 notifies the storage device 101
5 of a new physical network ID of the corresponding computer 111 with the computer ID that is uniquely matched to the computer 111 if the physical network ID of the computer 111 is dynamically changed through the use of the DHCP (Dynamic Host Configuration Protocol).
10 As another method of causing the storage device 101 to make the computer ID correspond with the physical network ID, it is possible to employ a method of causing the processor 102 of the storage device 101 to monitor the protocol of the DHCP through the network
15 interface 105, detect obtention of the physical network ID by the computer 111, and then obtain the physical network ID.

In such a narrow network that no communication through a router is necessary, the MAC
20 address and the World Wide Name, both of which are not dynamically changed, may be assigned to the computer ID and the physical network ID. However, if the communication uses the router, the MAC address and the World Wide Name owned by the computer 111 do not reach
25 the storage device 101. Hence, they cannot be used for the physical network ID.

Fig. 4 is a flowchart showing a process of collecting an access history when the computer 111 is

started in the present embodiment. Herein, the
description will be oriented to the process of
collecting an access history when the computer 111 is
started. The access history collection timing is

5 optional. As mentioned above, if the storage device
101 receives the StartRec command from the management
computer 108, the storage device 101 executes the
process of collecting an access history (to be
discussed below). It means that it is possible to

10 designate the storage device 101 to start obtention of
the access history of the computer before the computer
111 is started.

However, if the physical network ID is
dynamically allocated to the computer 111, the storage

15 device 101 disables to specify the computer 111 until
the assignment of the physical network ID is terminated.
Hence, the access history collection is started after
the physical network ID is assigned.

Further, the administrator may transmit the

20 "TimeoutRec" command to the storage device 101 through
the use of the management computer 108 in advance, for
the purpose of specifying to the storage device 101 a
limitation time of the collection of the access history
corresponding with the specified computer ID and

25 history ID, in other words, the time when the access
history collection is completed. For example, by
measuring the time taken until the computer 111 enters
into the starting state in advance and specifying the

time taken until the computer 111 finishes its operation to the storage device 101 before the computer 111 is started, the storage device 101 may obtain the access history only when the computer 111 is started.

5   Moreover, the administrator causes the storage device 101 to start collection of the access history for the access pattern specified by the specified history ID through the use of the "PointRec" command if the access history collection start

10   condition of the computer 111 with the specific computer ID is met at any step of the process shown in Fig. 4. For example, the administrator may specify the time when the computer 111 starts to read the operating system or the time when it starts to read a specific

15   application program.

In a case that the physical network ID for the computer 111 is dynamically allocated after the computer is started, in the process shown in Fig. 4, the corresponding physical network ID with the computer

20   ID of the computer 111 is determined. Then, after the storage device 101 obtains the information, the storage device 101 determines if the history collection start condition is met. If met, the process specified by the "PointRec" command is started. Hereafter, the process

25   will be described in detail.

At first, the processor 102 of the storage device 101 stays in the waiting state. The processor 102 monitors whether or not there exists a computer 111

that meets the history collection start specified by the management computer 108 and the read-ahead start condition (for example, the start of a specific application program or an OS) specified by the

5 "PointRead" command. Further, the processor 102 may also monitor whether or not there exits a computer 111 that obtains the physical network ID by monitoring the network 109 (step 501).

The management computer 108 transmits a

10 signal for starting the corresponding computer 111 with the computer ID through the network 109 (step 502).

The computer 111 that has received the start signal initiates the starting process (step 503).

In a case that the physical network ID of the

15 computer 111 to be started is dynamically determined and the computer 111 uses the storage device 101 since it is started, the computer 111 obtains the physical network ID from the network server 110. In this case, if the storage device 101 monitors assignment of the

20 physical network ID to this computer 111, the storage device 101 registers in the history information management table 301 the observed physical network ID in linkage with the computer ID of the computer 111 that obtains the physical network ID (step 504).

25 In a case that the physical network ID of the computer 111 is dynamically determined, the management computer 108 obtains the physical network ID allocated to the computer 111 by the network server 110.

Afterwards, the management computer 108 records the relation between the obtained physical network ID and the computer ID of the computer 111 to which the physical network ID is allocated in a memory owned by

5   the management computer 108 itself (step 505).

In a case that the storage device 101 does not monitor assignment of the physical network ID to the computer 111, the management computer 108 notifies the storage device 101 of the corresponding physical

10   network ID with the computer ID through the use of the RegistID command (step 506).

Then, the administrator causes the management computer 108 to specify the computer ID and the history ID to the storage device 101 through the use of the

15   "StartRec" command and then to designate the storage device 101 to start the access history collection (step 508). Herein, the step of starting the access history obtention is described in the location 508 in Fig. 4. However, the history information collection start does

20   not necessarily take place once. The designation of starting the history information collection to the computer with the different computer ID may take place at any step.

When the history collection start is

25   designated, the processor 102 of the storage device 101 selects a request for an access from the computer with the physical network ID from all requests for accesses to the disk group, received by the storage device 101,

through the use of the corresponding physical network ID with the computer ID to which the collection is designated and then saves the selected access request in the history information list 302. In the list 302, the history ID specified when the history collection is started is related with the access content saved in the history information list 302.

As shown in Fig. 6, the physical network ID 702 for indicating the transmitter 111 that has transmitted the access request is included in the packets of the access request transmitted by the computer 111. Hence, the access request may be selected in the storage device 101. If the access request is transmitted from the computer 111 with the corresponding physical network ID with the computer ID whose history is not requested to be collected, the access request is not saved (step 509).

If the limitation time is set to the history collection, the processor 102 determines if the access history collection in execution continues over the limitation time (step 510). If yes, the corresponding history information collection with the target computer ID is terminated (step 514).

If not, the processor 102 checks if the history collection stop command "EndRec" is issued by the management computer 108 (step 511). If issued, the processor 102 terminates the corresponding history information collection with the target computer ID

(step 514). If not issued, the processor 102 repeats the process of the step 509 or later.

After the history collection is stopped in the step 514, the processor 102 checks if the overall history information collection is stopped. If yes, the processor 102 shifts into the waiting state, while if no, the processor repeats the process of the step 509 or later (step 512).

If no dynamic change of the physical network ID takes place, when the access history collection is designated to the storage device 101 again after the process (steps 502 to 507) of obtaining the information of the physical network ID is ended once, the process of the step 507 or later is performed. On the other hand, if the dynamic change of the physical network ID takes place, when the history information collection is designated to the storage device 101 again, the process of the step 504 or later is performed.

If the physical network ID is specified (not dynamically) in advance, the designation for the history information collection may be executed at the step 506 or later.

Further, a plurality of history collection designations may be given to the storage device 101. In this case, the storage device 101 collects a plurality of access histories in parallel. For this purpose, the number of the computers to be used may be singular or plural. Moreover, if another computer 111

is started while the storage device 101 is collecting

the access histories of a certain computer 111, the

process shown in Fig. 6 to the newly started computer

111 is executed in parallel to the collection of the

5 access histories.

Fig. 5 is a flowchart showing a process of

causing the management computer 108 to designate the

storage device 101 to execute the read-ahead operation

of the disk device 104 to the cache memory 107 when the

10 computer 111 is started through the use of the history-

collected result. The process of the steps 601 to 606

is the same as the process of the steps 501 to 506 in

collecting the history information.

The administrator causes the management

15 computer 108 to transmit the "StartRec" command for

indicating the read-ahead start to the storage device

101, specify the history ID, and designate the storage

device 101 to start the read-ahead operation. (step

607).

20 The storage device 101 operates to refer to

the history information management table 301 and

execute the read-ahead of the disk group into the cache

memory 107 through the use of the access history of the

corresponding history information list 302 with the

25 designated history ID. Specifically, the storage

device 101 operates to retrieve the access history of

the history information list 302 related with the

designated computer ID and history ID, read out data

from an access location, i.e. an address, to the disk
group 104, which is registered in each retrieved access
history, and then save the data in the cache memory 107.
If a plurality of access histories correspond with the
5   history ID, the storage device 101 also operates to
sequentially read out the corresponding data with those
access histories (step 608).

       If no access history corresponding with the
designated history ID is found (all are read out or
10   nothing is originally registered), the storage device
101 terminates the read-ahead operation and then
returns into the waiting state (step 609).

       The system administrator may cause the
management computer 108 to designate the storage device
15   101 to execute the read-ahead operation in the other
time rather than the time when the computer 111 is
started. In this case, if the physical network ID is
not dynamically changed or not dynamic, the process of
designating the storage device 101 to execute the read-
20   ahead operation is executed from the step 607. If the
physical network ID is dynamically changed, the process
is executed from the step 604.

       Further, the system administrator may
transmit a plurality of read-ahead designations to the
25   storage device. In this case, the storage device 101
executes the read-ahead of data based on the
corresponding access histories with the specified read-
ahead designations.

The description has been heretofore expanded on the assumption that the system administrator directly inputs the history ID and the computer ID to the management computer 108. However, as the computers

5   111 that use the storage device 101 has increased in number, it is not realistic that the administrator directly inputs the history ID and the computer ID to the management computer 108. Hereafter, the description will be expanded about the embodiment in

10 which the system administrator may more easily manage the history ID and the computer ID.

In this embodiment, for simplifying the access history management and thereby reducing the burden of the management, the management computer 108

15 is provided with a history management program. The management computer 108 causes the history management program to execute the read-ahead schedule management by managing the computer ID and the history ID and designating the history ID to the storage device 101.

20   Fig. 7 is a table showing the information included in the management computer 108 for managing the computer 111 that uses the storage device 101.

Herein, the information is managed in the form of the table (referred to as the "management

25 table"). The system administrator inputs the information for specifying the computer(s) 111 that use(s) the storage device 101, herein, the computer name(s) and the computer ID(s) through an input

interface (such as an input screen) included in the
management computer 108. The management computer 108
registers in the management table the inputted computer
ID(s) and computer names as being linked with the

5   physical network ID. In this case, if the currently
inputted computer name and ID are newly inputted, the
management computer 108 may display a warning to a
person who inputs the data.

As another method, the management computer

10   108 is programmed to obtain the corresponding
information of the computer ID and the physical network
ID from the network server and display the data on the
screen of the management computer 108 itself so that
the system administrator may select the computer ID and

15   the physical network ID and then input the
corresponding computer name on the screen.

Moreover, the administrator may classify a
plurality of computers into some groups, for more
facilitating management of those computers. In this

20   case, the administrator inputs to the management
computer 108 the plurality of computer names and a
computer group name for managing them at a batch. The
management computer 108 operates to allocate an
identifier (computer group ID) to each computer group

25   name and then register in the management table the
computer group name and the computer names and the
computer IDs included in the group as being linked with
one another. Further, the management computer 108 is

caused to display on the screen a list of computer
names registered in the management table so that the
administrator may select the proper computer names and
register them as one computer group.

5   As set forth above, since one or more
computers 111 may be managed with the name the system
administrator may more easily leave in mind, it is
possible to lessen the administrator's burden of
specifying the computer when he or she designates the
10   storage device 101 to execute the read-ahead or collect
the history information. Moreover, the read-ahead
designations to a plurality of computers may be
executed at a batch.

Fig. 8 is a table showing the exemplary
15   information included in the management computer 108 for
managing the history ID to be specified to the storage
device. Herein, the information is managed in the form
of the table (referred to as the "history ID table").

The administrator registers the collected
20   access pattern as the name (history name) to be easily
identified. The management computer 108 allocates the
history ID to the inputted history name and then
registers in the history ID table the history name and
the history ID as being linked with each other. If the
25   existing history name is newly inputted, the management
computer 108 may report a warning to a person who
inputs the data. Further, the management computer 108
accepts the inputs of the history name and the computer

name from the administrator and an input of designating deletion of it and then deletes them.

As mentioned above, the history ID is allowed to be managed by the system administrator in the name

5 that concretely indicates the corresponding access pattern with the history ID. This leads to lessening the burden of the administrator in designating the read-ahead or the collection of the history information.

The foregoing two tables allow the

10 administrator to input the computer name (or the computer group name) and the history name to the management computer 108. This thus makes it possible to more easily designate the storage device 101 to execute the read-ahead operation about a specific

15 computer 111 or collect the history thereabout.

Fig. 9 is a table showing an example of a job management table included in the management computer 108. This job management table is used so that the management computer 108 may manage the schedule for

20 designating a group of processes such as a series of read-ahead designations to the storage device 101. The administrator inputs a series of designations to the storage device 101 into the management computer 108. The concrete contents of the designations include a

25 history ID for indicating the access pattern to be pre-read, a time when the access pattern is to be executed, a computer ID for indicating the target computer 111 (or the computer group), and so forth. Herein, in

place of the computer ID, the computer name or the
history name may be used.

The management computer 108, which has been
inputted with these contents of designations, defines
5   one inputted designation content as one job by linking
an identifier of a job ID with the designation content,
and then record the job in the job management table.
In this case, if a plurality of designation contents
are inputted at a time, the same job ID may be
10   allocated to the plurality of designation contents.
This allows the system administrator to designate the
plurality of designation contents to the storage device
101 with one job ID.

The job management table includes an entry
15   for one job. Each entry includes a plurality of fields.
Concretely, they are a field in which a job ID of the
corresponding job with an entry is registered, a field
in which a computer ID or a computer group ID
designated by the job is registered, a field in which a
20   history ID designated by the job is registered, a field
in which the job start condition is registered, a field
in which the job start time is registered, and a field
in which the information for indicating whether or not
started is the computer 111 to which the job is
25   oriented.

Herein, for example, as to the job in which
the job start condition field included in the job
management table is set as "manual", the job is

executed by the job start designation given by the administrator. That is, the management computer 108 designates the content designated by the job to the storage device 101. On the other hand, if a time is

5   specified in the job start condition field, the management computer 108 operates to designate the corresponding content with the job to the storage device 101 when the time reaches the specified time.

If the condition for starting the

10   corresponding computer 111 with the job is specified as the job content after the read-ahead of the data specified by the job, concretely, if "yes (three minutes later)" is specified, the management computer 108 transmits the indication of start to the

15   corresponding computer 111 three minutes later than the time when the read-ahead is designated to the storage device 101.

In the foregoing description, one entry is matched to one job. In place, if one job is matched to

20   a plurality of designation contents, a plurality of entries may be arranged to match to one job. Or, one entry is arranged to match to one job and the information for specifying a plurality of objects, for example, a plurality of history IDs or a plurality of

25   computer IDs may be registered in each field. Further, the job management table includes a field in which the job name for the job ID is registered so that the management computer 108 may retrieve the job if the

administrator registers just a job name. In this case,
the administrator inputs a job name and thereby
registers the job when he or she inputs the content of
the job.

5   Further, in the field where the job execution
condition is registered, the other information than
"manual" and "time" may be registered. For example, by
registering the address and the time to be processed by
the "PointRead" command, the job may be created so that
10   the management computer 108 designates the storage
device 101 to start the read-ahead process if the
storage device 101 senses the read of a specific
application.

          Fig. 10 is a flowchart showing a process of
15   causing the management computer 108 to designate the
storage device 101 to execute the job through the
history management program. The management computer
108 in the waiting state (step 1101) starts the job
when the administrator designates the job start or the
20   current time reaches the time indicated in the start
condition of the job management table. Hence, the
management computer 108 is constantly checking if the
current time reaches the start time of the job
registered in the job management table (step 1102).

25   When the management computer 108 detects the
job start designation or that the time reaches the
predetermined time, the management computer 108 obtains
a job ID of the job designated by the administrator or

the job ID of the job whose start time comes from the job management table (step 1103). Afterwards, the management computer 108 obtains the computer ID and the history ID of the job management table corresponding

5   with the obtained job ID, specifies the obtained computer ID and history ID, and then designates the storage device 101 to start the read-ahead process (step 1104).

The storage device 101 selects from the

10 history information list 302 the corresponding access history with the computer ID and history ID specified by the management computer 108 and executes the read-ahead of data to the cache memory based on the history. Herein, if the job includes a plurality of computers

15 IDs or history IDs, the storage device 101 executes the read-ahead process based on the corresponding access history with these plurality of history IDs or computer IDs (step 1105).

Moreover, if the computer start is specified

20 as "yes" in the yes or no of the computer start in the job management table, the management computer 108 obtains from the computer group table the computer ID belonging to the computer group ID a specified time later and then transmits a start signal to each of the

25 computers 111 (step 1106).

As mentioned above, merely by setting the process of designating the read-ahead once, the administrator causes the management computer 108 to

automatically designate the read-ahead to the storage
device 101. This saves the administrator's burdensome
work of designating the read-ahead.

In the foregoing embodiment, the management
5 computer 108 merely designates the scheduled read-ahead.
The schedule may include the designation of collecting
the access history. In this case, the job management
table includes as a new item a field in which
registered is the content to be designated to the
10 storage device 101, for example, the designation of
starting collection of the access history.

It should be further understood by those
skilled in the art that although the foregoing
description has been made on embodiments of the
15 invention, the invention is not limited thereto and
various changes and modifications may be made without
departing from the spirit of the invention and the
scope of the appended claims.